Thesis Project Portfolio

Hydrologic Modeling and System Optimization for IoT Flood Management

(Technical Report)

Analysis of the factors that affect homeowners being denied flood insurance coverage

(STS Research Paper)

An Undergraduate Thesis

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Khwanjira Phumphid

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Department of Civil and Environmental Engineering

Contents of Portfolio

Executive Summary

During the last two decades, climate change has become predominant. It causes weather fluctuation and intensive storms. As a result, flooding has become often and high hazard. It can devastate people's properties and homes within a short period. Also, it can cause several social problems, such as road closure, school pauses, and unemployment. Flood impacts not only physically humans but also people who never experienced floods before and may internally have anxiety. Therefore, the government and several studies have been conducted to find ways to prevent and mitigate loss. Technology is also playing an essential role in this part. New tools such as flood warning systems, precise weather forecasts, and water sensors are introduced. In addition, mitigation methods such as flood insurance can help endure the loss. In this project, two topics relating to flood prevention strategies are explored. The technical project is about utilizing flood sensors for IOT flood management. In comparison, the STS paper explores the factors that impact homeowners not purchasing flood insurance.

The Internet of Things (IoT) has been developed more frequently. Combining IoT with water sensors can help create better hydrologic systems responding to extreme rainfall events. The hydrologic system can be applied to create flood emergency management. This technical project studies two approaches to water sensors. First, we created a hydrological model for the Charlottesville area focusing on the Dell Pond. ArcGIS is used to obtain parameters for the model from geospatial datasets such as elevation, soils, land use, and land cover. Then, the parameters derived from ArcGIS combined with National Oceanic and Atmospheric Administration (NOAA) rainfall precipitation data can create a hydrologic model in HEC-HMS. The second study is about the battery life of the sensor. Since the sensor uses the traditional lithium battery, it requires battery replacement to maintain the best performance. Water sensors from a station are tracked to obtain the battery voltage over time. The data are plotted and fit with a polynomial math curve to find the battery life before requiring a replacement. We also created the prediction model to predict the battery voltage for the near future. The predicted voltage from the

model is compared with the actual voltage. We found out that the created model gives a practical result. We also deployed a new water level and a soil moisture sensor using the IoT network at Dell Pond. These studies contribute a simple approach to flood monitoring systems. They can be integrated into next-generation flood management and warning systems that use IoT monitoring networks.

From recent news about Hurricane Ian, only 29 percent of Florida residents have federal flood insurance. Flood insurance is still not a majority choice for people who live in the United States. From global climate change and high-hazard flooding, flood preventive methods and structures are inefficient in protecting individual property. Flood insurance should be the best way to endure the loss from a devastating flood event. Therefore, a study about the factors that impact people from denying purchasing flood insurance is important. Several approaches, such as people's perception of risk, global climate change, and flood insurance, are internal factors that should be investigated. Considering human action, it can be triggered by the fear of humans on uncertainty. The belief of humans about the source of climate change can also have a relation to individual behavior. However, we found an interesting result that people who live in a higher-risk area have a lower incentive to purchase insurance than those in lower-risk areas. This statement is supported by an analysis derived from investigating human experiences and external factors. The personal experience of flooding causes adaptative prevention. For those who have never experienced flood events, the awareness rate of people in a flood-prone area is almost equal to people living outside a high-risk area. In addition, when the risk has less impact on the decision, socioeconomic factors such as education, salary, and property cost greatly influence the people.

The two studies are valued as beginning steps for further studies. They achieved most of the plan, but the improvement can still be made to improve them. For the technical project, I would like to add real-time precipitation data to the model, but we were not able to do so. The sensor is deployed later than we expected, so we cannot add the data from the sensor to our model. While writing the STS research paper, I would like to add some of the statements to develop my paper. However, there is a moderate

amount of research relating to this field. Therefore, some of the statement is dropped because I cannot find information to support the statement.